

Marking Schemes

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Paper 1

SECTION A

Question No.	Key	Question No.	Key
1.	D (60%)	21.	C (71%)
2.	D (63%)	22.	D (67%)
3.	C (57%)	23.	B (48%)
4.	D (85%)	24.	D (66%)
5.	B (42%)	25.	D (65%)
6.	A (62%)	26.	B (35%)
7.	C (65%)	27.	B (75%)
8.	B (38%)	28.	A (12%)
9.	A (57%)	29.	C (60%)
10.	B (52%)	30.	B (44%)
11.	C (63%)	31.	B (30%)
12.	C (58%)	32.	A (54%)
13.	A (53%)	33.	B (80%)
14.	A (73%)	34.	C (61%)
15.	D (75%)	35.	A (47%)
16.	D (40%)	36.	C (54%)
17.	C (38%)		
18.	A (68%)		
19.	C (73%)		
20.	D (70%)		

Note: Figures in brackets indicate the percentages of candidates choosing the correct answers.

Paper 1 Section B

Marks

1. (a) pancreas* (1) (1)

(b)

Concept for mark award: • identification of the components in the secretion of duct B which are related to fat digestion (1) and how digestion of fat is affected by the process related to the components (1) x2	(4)
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e.g.

blockage of duct B by gallstones will result in: (any *two* of the following sets)

- decrease in the secretion of bile salts (1), which in turn decreases the emulsification of fat in the small intestine (1)
- decrease in the secretion of lipase (1), which in turn decreases the chemical digestion of fat in the small intestine (1)
- decrease in the secretion of sodium hydrogen carbonate (1) such that the pH in the small intestine is no longer optimum for the digestion of fat (1)

5 marks

2. (a) • synapse* (1) (1)

(b) (i) • terminal X (1) (1)

(ii) • neurotransmitter W at location 1 diffuses to the membrane of terminal Y (1)
 • neurotransmitter W stimulates the membrane at terminal Y / binds to the receptor on the membrane of terminal Y to initiate a nerve impulse (1) (2)

(c) • this ensures that the neurotransmission takes place in one direction only (1) (1)

5 marks

3. (a) (i) • the greater the total cross-sectional area, the slower the blood flow / the smaller the total cross-sectional area, the faster the blood flow (1) (1)

(ii) • the blood flow in the capillaries is the slowest / very slow (1)
 • this allows more / enough / sufficient time for the exchange of materials in the capillaries (1) (2)

(b)

<i>Features illustrated in the diagram</i>	<i>Importance to material exchange</i>	
the capillaries are highly branched / form a dense network (1)	to increase the surface area for the exchange of materials (1)	(4)
the capillaries penetrate tissues / reach most of the cells in the tissues (1)	to shorten the diffusion distance (1)	

7 marks

4. (a)

Solution injected	Mean flight time (s)	
inhibitor of trehalose-digesting enzyme	85.2	(1)
inhibitor of glycogen-digesting enzyme	163.2	

- (b) Concept for mark award: (4)
- comparison of the results of the experimental set-up and control set-up to draw conclusions (1+1) x2

e.g.

- the flight time of insect species A was decreased markedly by the inhibitor of the trehalose-digesting enzyme as compared to the saline control (1), which shows that the energy supply was halted once the digestion of trehalose was inhibited; therefore, trehalose is the energy reserve for flight in insect species A (1)
- the flight time of insect species A treated with the inhibitor of the glycogen-digesting enzyme was comparable to the saline control (1), which shows that the energy supply was not affected even though the digestion of glycogen was inhibited; therefore, glycogen is not the energy reserve for flight in insect species A (1)

- (c) • the amount of trehalose storage / size of the wings / size or mass of the individuals / age of the individuals / sex (1) (accept other reasonable answers) (1)

6 marks

5. (a) • mitotic cell division (1) (2)
- root tip is the vegetative part of the plant / is not the reproductive part of the plant / is the region for growth (1)

- (b) • use a stain to stain the chromosomes / staining / any named stain (1) (1)

- (c) (i) $W \rightarrow Y \rightarrow X \rightarrow Z \rightarrow V$ (1 or 0) (1)

(ii)

Stage	Number of chromosomes	Number of chromatids	
Y	16	32	(1)
Z	32	0	(1)

6 marks

6. (a) Concept for mark award: (4)
- recognition of antigen Y as a foreign antigen (1)
 - production of memory cells for antigen Y (1)
 - 2nd encounter of antigen Y on pathogen X (1)
 - elicitation of secondary immune response (point out the characteristics of the secondary immune response) (1)

e.g.

- after injection of antigen Y into the human body, B-lymphocytes will recognise antigen Y as a foreign antigen (1)
- the B-lymphocytes will produce memory cells for antigen Y (1)
- when pathogen X bearing antigen Y invades the body in the future, these memory cells can recognise the same antigen (1)
- and elicit a secondary immune response that produces a large number of antibodies in a short time (1) to eliminate the invading pathogen X

- (b) • vaccine derived from the weakened pathogen (1) (1)

- (c) (i) • Met Ala Ile Asn Cys Cys (2 marks, deduct 1 mark for each mistake) (2)

- (ii) Concept for mark award:
- correct choice of strain (1)
 - the effect of the stop codon on the polypeptide produced (1)
 - the effect on the antigen produced (1)
 - the failure to recognise the pathogen (1)
- (4)

e.g.

- strain Q (1)
- TGA becomes the stop codon and so the polypeptide produced is much shorter (1)
- therefore, no antigen Y will be produced / the antigen produced will have a different shape (1)
- the memory cells for antigen Y can no longer recognise the pathogen (1)

11 marks

7. (a) Concept for mark award:
- consequence of flowering (1)
 - explanation of how the chance of survival can be increased (any one of the following approaches):
 - dispersal of fruits / seeds (1) + description of how dispersal increases survival (1)
 - seeds can stay inactive (1) + description of how this increases survival (1)
 - dispersal of fruits / seeds (1) + seed can stay inactive (1)
- (3)

e.g.

- flowering results in the formation of fruits and seeds (1)
- (any **one** of the following sets)
- fruits / seeds are the dispersal units which allow the progeny / offspring to be dispersed away from the mother plants (1); thus the progeny / offspring can escape from the adverse conditions (1) and have a higher survival rate
- the seeds can survive / remain inactive throughout the period with adverse conditions (1) and germinate when the conditions become favourable again (1)
- fruits / seeds are the dispersal units which allow the progeny / offspring to be dispersed away (1) from the mother plants while the seeds can survive / remain inactive throughout the period of adverse conditions (1)

- (b) (i) • both bee damage and mechanical damage would shorten the flowering time to a similar extent (1) (1)

- (ii) Concept for mark award:
- comparison of effects of different treatments with the control (1) to draw valid conclusions (1) x2
- (4)

e.g.

- the time taken to flower in the plants with mechanical damage was shorter than in plants without damage (1), showing that mechanical damage can induce flowering (1)
- however, bee damage advanced the flowering time a lot more than pure mechanical damage (1), which shows that there were factors other than mechanical damage which induced the flowering (1)

- (c) • It can ensure that there is a match between the timing of flower production and colony establishment / the bees can induce flowering when they are establishing their colonies / it can ensure that there is a sufficient food supply for the colony (1)

9 marks

8. (a) • leaves taken from the lower region have a larger leaf area than those from the upper region (1) (2)
 • a larger surface area increases the chance of capturing light (1)
- (b) (i) • leaves taken from the upper region have a thicker palisade mesophyll than those taken from the lower region (1) (1)
 (ii) • longer palisade cells / additional layers of palisade cells (1) (1)
 (iii) • observe a cut section of the leaf under the microscope (1) (2)
 • measure the length or size of the palisade mesophyll cell / count the number of layers of palisade mesophyll cells (1)
- (c) (i) • respiration is faster than photosynthesis (1), resulting in a net release of carbon dioxide (1)
 (ii) • line with a higher starting point (1) (data interpretation: the amount of respiring tissue is smaller, so the amount of carbon dioxide produced is smaller when light intensity is zero) (2)
 • line indicates that a lower net CO₂ uptake can be reached (1) (data interpretation: the amount of photosynthetic tissue is smaller, therefore the amount of carbon dioxide uptake is smaller)

9 marks

9. (a) • they were each other's competitor (1) because their percent coverage / growth rate when grown together is lower than when grown alone (1) (4)
 • Species 1 was more competitive than Species 2 (1) as the drop in coverage / growth rate for Species 2 was much higher than that for Species 1 (1)
- (b) • larger leaves enabled Species 1 to be more successful in overtopping / shading Species 2 (1) (2)
 • and so increased its competitiveness for light / surface space (1)

(c)

<i>Method</i>	<i>Feasibility</i>	<i>Reason</i>
Fresh weight	Feasible	plenty of water supply, fresh weight will not be affected / the experiment can be continued without killing the plants (1)
Number of leaves	Not feasible	leaf can grow in size without an increase in number / difficult to count / uncountable (1)

8 marks

10. (a) (i) • Step 1 simulates / mimics the pH condition / acidic condition / the presence of gastric juice in the stomach (1)
 • while Step 4 simulates / mimics the pH condition / alkaline condition / the presence of pancreatic juice / intestinal juice / bile juice / neutralisation of the gastric juice in the small intestine (1) (3)
 • and thus provides optimal / proper / suitable pH conditions for enzymatic digestion (1)
- (ii) • to stop the activity of the enzymes / the enzymatic reaction / denature the enzymes (1) (1)
- (iii) • this shows that the short RNA fragments were not digested into nucleotides (1)
 • the RNA fragments are too large to pass through the wall of the small intestine / the small intestine cannot absorb the short RNA fragments as they are too large (1) to pass through effectively (2)
- (b) any *one* of the following:
 • check whether the cells can pick up these short RNA fragments (1)
 • check if these short RNA fragments in the milk vesicles can be detected in the infants, other than in the digestive tract in vivo, e.g. other organs / in the blood (1) (1)
 • check if the presence of these short RNA fragments will affect gene expression (1) (accept other reasonable answers)

7 marks

11. Concept for mark award:

Source of variation (max. 5):

- sexual reproduction produces offspring with a mix of genetic materials from parents (1)
 - production of gametes by meiosis (1)
 - different combinations of chromosomes due to independent assortment (1)
 - new combinations of alleles in chromosomes due to crossing over (1)
 - zygote has different combinations of genetic materials due to random fertilisation (1)
 - mutation resulting in new alleles (1)
 - environmental factors, with suitable example for illustration (1)
- max. 5

Importance of variations (max 3):

- how variations cope with different environmental conditions, e.g.
 - variations lead to different niches (1), allowing the exploration of different resources / reduced competition (1)
 - how variations cope with environmental changes over time, i.e. concept of natural selection, e.g.
 - provide a range of variants within the same species for natural selection; when there are environmental changes, organisms with better adapted traits are selected and survive (1) whereas less adapted ones are eliminated (1)
- max. 3

Effective communication (0-3)

max.3
11 marks

Paper 2 Section A

Marks

1. (a) (i) • both the heart rate and the blood lactate concentration increased (1) as the intensity level of exercise increased (1)
- (ii)

Concept for mark award: <ul style="list-style-type: none"> • energy required for exercise > energy produced by aerobic respiration (1) • additional energy supply from anaerobic respiration (1) • lactic acid as a product which accumulates (1) 	(3)
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 e.g.
 - the energy consumed exceeded energy produced aerobically by the muscle due to insufficient oxygen supply (1)
 - the muscle underwent anaerobic respiration at the same time to produce extra / additional energy (1)
 - as anaerobic respiration produced lactic acid which accumulated in the blood / the production of lactic acid from anaerobic respiration is faster than its break down (1)
 so the blood lactate level increased during exercise
- (iii)

Concept for mark award: <ul style="list-style-type: none"> • correction stimulus + detection (1) • action of cardiovascular centre + destination (1) • generation of electrical signals (1) • correction response (1) 	(4)
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 e.g.
 - increase in blood lactate level results in a drop in blood pH, which is detected by chemoreceptors in medulla oblongata (1)
 - the cardiovascular centre in the medulla oblongata sends more nerve impulses to the pacemaker / sinoatrial node along the sympathetic nerve (1)
 - the pacemaker / sinoatrial node generates more electrical impulses that spread through the cardiac muscles / heart muscles (1)
 - this causes the cardiac muscles / heart muscles to contract faster (1), which increases the heart rate

(iv) Any *two* of the following:

 - Alice's resting heart rate / heart rate at each fixed speed was lower than Billy's throughout (1)
 - Alice's heart rate increased less than Billy's (1)
 - Alice's had a lower blood lactate concentration at each fixed speed (1)
 - Alice's blood lactate concentration rose more slowly than Billy's (1)
 (2)

(b) (i) • receptor: thermoreceptors in hypothalamus (1)
 • effectors: sweat glands (1) (2)

(ii)

Concept for mark award: <ul style="list-style-type: none"> • there is a normal value to be maintained (1) • the deviation in the value triggers a response, sweating in this case (1) • describe how the response, i.e. sweating, brings about a correction (2) 	(4)
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 e.g.

 - there was a normal value for body temperature which was 37°C for the isotonic group (1)
 - once the body temperature rose above this value, it triggered the sweating process (1)
 - evaporation of sweat absorbed heat energy from the body (1)
 - trying to lower the body temperature until it returns to normal range (1)

- (iii)
 - the curve of the hypertonic group showed a shift to the right / delayed / higher threshold for the onset of sweating (1)
 - this shows that the set-point of the negative feedback mechanism shifted to 37.5°C (1)(2)

- (iv)
 - the water potential was lower in the body fluid of the hypertonic group, and so the delay in the onset of sweating reduced water loss through sweating (1)
 - thus conserving more water at the expense of thermoregulation (1)(2)

20 marks

Paper 2 Section B

2. (a) (i)
- | | |
|---|-----|
| Concept for mark award: <ul style="list-style-type: none"> • comparison of the correct sets of data (1) • implication of the difference between the data sets (1) • how the removal of weeds can increase the crop yield (1) | (3) |
|---|-----|

e.g.

- there were fewer plant species in the conventional farm than in the organic farm (1)
- this shows that the use of herbicides was effective in removing weeds / plant species other than crops (1)
- this reduces the competition for resources from weeds (1), increasing the crop yield

- (ii)
- | | |
|---|-----|
| Concept for mark award: <ul style="list-style-type: none"> • comparison of the correct sets of data (1) • implication of the difference between the data sets (1) • use of the correct sets of data to explain why the population of pest A was suppressed (2) | (4) |
|---|-----|

e.g.

- there were fewer pest A in the organic farm than in the conventional farm (1)
- this shows that organic farming / biological control was more effective in controlling pests than conventional farming / chemical control (1)

Either *one* of the following sets:

- the use of insecticides also killed some predators of A in conventional farming (1); with fewer predators, the population of pest A increased (1)
- organic farming maintained a higher number of predators of A (1); with more natural predators, the population of pest A was suppressed (1)

- (iii)
- | | |
|--|-----|
| Concept for mark award: <ul style="list-style-type: none"> • comparison of the correct sets of data (1) • relate the data to the sustainability of plant species (1) • explain how the abundance of plants species is beneficial to the sustainable development of animal species (1) | (3) |
|--|-----|

e.g.

- higher species diversity / species richness of both plants and pollinators was noted in areas around the organic farm (1)
- the large number of species of pollinators enhanced the reproduction of flowering plants (1), the sustainability of plant species was maintained
- the large number of plant species provided a variety of food sources to support the growth of animal species (1)

Marks

- (b) (i) • phosphate is an essential nutrient for the growth of phytoplankton (1)
• therefore the addition of phosphates to lakes results in an increase in the population size of phytoplankton (1) (2)
- (ii) • the results showed that the population of zooplanktons in Lake A remained more or less the same (1) while the population of zooplanktons in Lake B increased (1) (3)
• a large population of zooplanktons helped remove / fed on phytoplankton in Lake B, keeping the population of phytoplankton under control (1)
therefore, there was a lower chance of algal bloom in Lake B than Lake A
- (iii) • Fish Species 2 consumed Fish Species 1 (1)
• so the predation pressure on zooplankton decreased / there were fewer predators / Fish Species 1 to feed on zooplankton (1) (3)
• when phosphate was added to Lake B, an increase in phytoplankton biomass provided more food to zooplankton (1) which resulted in an increase in their population
- (iv) • at night the dissolved oxygen content in water decreases because the large population of algae stops photosynthesizing (1) but continues to consume oxygen in respiration (1) (2)

20 marks

Paper 2 Section C

3. (a) (i)

Concept for mark award: • relate the data / practice to the growth of the bacterium (1+1) x2

 (4)
- e.g.
Any *two* of the following sets:
• the bacterium can grow in a refrigerator (1) because the lower temperature limit for its growth is below 4°C (1)
• these food products will be consumed without cooking (1), so if the bacterium is present in the food, it will not be killed (1)
- (ii) (1)

Concept for mark award: • idea of temperature shock: exposure to a high temperature for a brief period (1) followed by rapid cooling down (1)
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 (2)
- e.g.
• during pasteurisation, milk is heated to 75°C for a short period of time (1)
• and then cooled down rapidly to 10°C (1)
- (2) • the sudden change in the temperature during the treatment kills *Listeria monocytogenes* / 75°C is higher than the maximum temperature for the survival of *Listeria monocytogenes* (1) (1)
- (iii) (1) • 22 (1) (1)
- (2) • the plates should be autoclaved (1) (1)
- (b) (i) • the virus attaches to its host cell / injects viral DNA / RNA into the host cell / recognises host cells (1) (1)

- (ii) Concept for mark award:
- different shapes of membrane proteins (1)
 - the viral membrane proteins / receptors can only recognise the membrane proteins on the cells of the upper respiratory tract (1)
- (2)
- e.g.
- membrane proteins of the cells of the upper respiratory tract and lower respiratory tract are different shapes (1)
 - the virus can only infect cells of the upper respiratory tract because the protein on the virus surface fits / recognises / complements the shape of the membrane protein on upper respiratory tract cells (1)
- (iii) • pig viruses (1)
- Concept for mark award:
- pigs and humans have a closer phylogenetic relationship (1)
 - similar membrane proteins (1)
- (3)
- e.g.
- pigs have a closer phylogenetic relationship to humans / pigs and humans are both mammals / warm-blooded animals (1)
 - therefore the chance that pig viruses will acquire the ability to infect humans through mutation is higher than for fish viruses / the membrane protein of pig cells may be similar to that of humans (1)
- (iv) (1) • the viral nucleic acids take over the metabolic activities of the bacterial pathogens (1)
- to produce a large number of new bacteriophages (1)
 - after that the bacteriophages will burst and kill the bacterial pathogens (1)
 - the newly released bacteriophages can infect other bacterial pathogens in the food (1)
- (4)
- (2) • host-specificity ensures that only the targeted bacteria are eliminated / will not infect other normal microbes / the bacteriophages will not infect humans (1) (any other reasonable answers)
- (1)

20 marks

Paper 2 Section D

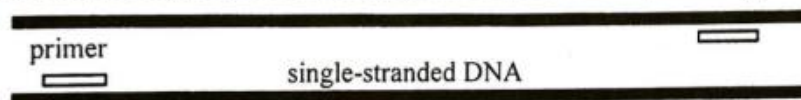
4. (a) (i) • should select stem cells / capable of producing cells continuously (1)
- the correct version of the gene will be expressed in the cells produced from these stem cells / the products of the corrected gene will be produced in the cells produced (1)
- (2)
- (ii) Any **one** set of the following:
- viral vector (1), advantage: can deliver the gene to specific host cells (1); disadvantage: safety concerns regarding viral residue / induces immune response (1)
 - gene gun (1), advantage: can deliver the gene to the any cells without limitation (1); disadvantage: random process, not sure if the insertion is successful / the gene can be expressed / cause mechanical damage to the cell (1)
 - micro-injection (1), advantage: precise delivery to the target cell (1); disadvantage: injection can cause damage / only one cell is targeted per injection (1)
- (3)
- Accept other reasonable answers

- (iii) • the gene therapy does not change the genetic composition of the sex cells / only changes the somatic cells of the patient (1), so the corrected version of the gene is not heritable
- he will pass his X-chromosome carrying the defective gene to his daughter (1)
- he will pass his Y-chromosome, i.e. free of the defective gene to his son (1)

- (iv) Any *two* of the following:
- the gene used in the therapy comes from humans / is not from other species, therefore, this method does not break the normal species barrier nature has set (1)
- the trait is not heritable and thus it will not change the genetic composition permanently (1)
- the corrected gene is already present in the genome (1)
- transgenic animals may upset the ecological balance if they are released into the natural environment (1)

- (b) (i) (1) • stage O (1)
- the temperature at stage N is high (1)
- which would lead to the denaturation of double-stranded DNA / separate double-stranded DNA to two single strands (1) for the binding of primers to the single-stranded DNA

- (2) showing 2 single-stranded DNA (1), correct positions of primers (1)



- (ii) • primer II (1) and primer IV (1)

- (iii) Concept for mark award:
- how DNA fragments can move along the gel (1)
 - the relationship between size and the speed the DNA fragments travel (1)
 - the use of DNA markers to confirm the size of the DNA bands (1)

- e.g.
- as DNA fragments are negatively charged, they will move along the gel and migrate to the positive pole (1)
 - shorter DNA fragments will migrate at a faster speed than longer DNA fragments (1)
 - the sizes of the PCR products can be determined by comparing their relative positions on the gel against a set of DNA markers with known lengths (1)

20 marks